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AUTHOR Stolte, Joanne B.; Biester, Thomas W.
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ABSTRACT

This paper examines the impact of a science career development program especially designed for students with deafness, titled "Is Science a Possible Career for You?" The program materials are designed for adolescents in residential school, day school, or mainstream settings where students use oral, finger spelling and speech, or total communication techniques. Lessons can be infused into an existing course and/or program. Program activities enable students to assess their interests, learn about the role of science in society, explore science careers, and explore the possibility of a science career for themselves. A field test was conducted at nine sites, involving approximately 130 students. Two evaluation forms were developed for use in the impact study--the Awareness of Science Form and the Student Attitude Inventory. Results indicated that students demonstrated growth in awareness of the nature of science, scientists, and the scientific enterprise. Extremely positive results were exhibited in students' attitudes toward the potential of deaf persons in science careers. There was only very slight evidence to indicate that students developed increased positive attitudes toward science and science careers and increased positive self-concept. (Contains 14 references.) (JDD)

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Research for Better Schools
444 North Third Street
Philadelphia, Pennsylvania
19123 · 4107

215 · 574 · 9300
(FAX) 215 · 574 · 0133

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OVERCOMING BARRIERS TO SCIENCE CAREERS: AN INVESTIGATION OF DEAF STUDENTS' CAREER DEVELOPMENT IN SCIENCE

Joanne B. Stolte
Thomas W. Biester

Research for Better Schools, Inc.

Paper presented at the
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INTRODUCTION

This paper examines the effects of Is Science a Possible Career for You? upon students participating in the field test phase of program development. This impact evaluation report supplements other documentation describing the program development effort. The study provides a preliminary indication of program impact, but it should not be regarded as a final summative evaluation of effectiveness. It should be clearly understood that the impact study was not conducted on a fully mature version of the program materials. Field test data were gathered primarily for program revision purposes. Still, the study provides a reasonable estimate of the anticipated program effects upon students.

Is Science a Possible Career for You? is a science career development program especially designed for deaf students. It was funded by a grant from the Physically Handicapped in Science Program, Division of Scientific Personnel Improvement of the National Science Foundation.

Handicapped students face several barriers when they consider science careers: the lack of role models, little science content in their schooling, discrimination, and negative personal aspirations. Deaf students face all these problems, yet suffer the additional burden of a communication barrier.

The program responds to these conditions. Designed to meet the unique needs of deaf students in language, science education, and science career development, it fills a void in the career development resources

now available for deaf students. The materials are sensitive to the syntax, vocabulary development, and experiences common to many deaf students. Their special needs in projective and imaginative thinking and in inquiry skills are also considered. Throughout the program, students are encouraged in many ways to study and learn more about science. The program offers role models, visits to places where scientists work, a look at what science-related jobs are available, an awareness of what science perparation beyond high school is now accessible, and a realization that science offers career opportunities for handicapped people, women, and/or minorities.

The materials are designed for thirteen- to sixteen-year olds in residential school, day school, or mainstream settings where students use oral, finger spelling and speech, or total communication techniques. Since the lessons are supplementary in nature, they can easily be infused into an existing course and/or program (e.g., a career development program, science course, or social studies program). The materials are versatile: they could be used as the basis of a one-day career workshop with follow-up activities; they could be used on successive days; or they might be integrated into the present curriculum.

The primary goal of the program is to encourage deaf students to consider science as a possible career. Specific objectives are:

- To develop in deaf students an awareness of their interests, assets, abilities, and needs
- To create in deaf students an awareness of science careers

- To develop in deaf students more positive attitudes toward science and science careers
- To encourage deaf students to explore science content
- To provide deaf students with role models in science careers
- To provide deaf students with opportunities to see people engaged in science
- To enable deaf students to consider and resolve potential barriers to scientific careers.

Is Science a Possible Career for You? is divided into three sections. The activities in the first section help the student answer the question, "Why Consider a Career in Science?" Seven activities give students opportunities to learn about their interests and to consider the role of scientific work in society today. In the second section, the activities explore with students, "What Do People in Science Do?" Information about a science career is studied in six activities. Finally, the third section helps students answer the question, "How Do You Find Out if Science is a Career for You?". Here, through field work and other activities, students explore the possibility of a science career.

The activities themselves are designed as teacher-led discussions to be used with small groups, where much of the direction for the activity can be based on students' individual experiences. This format also gives students opportunities to learn new science/career vocabulary.

For each activity, the Purpose is stated, needed Materials are listed, and a Discussion provides background information for the teacher/

counselor. Guidance for conducting the Activity is given in a question-and-answer format which suggests how the activity might progress.

Optional Activities are provided for most lessons. Since these usually expand upon some point in the main activity, they are meant for students with a demonstrated interest in science and/or strong language skills.

Notes and Comments give information about topics covered within the activity, such as remarks about deaf individuals presently in science-related careers. Teacher References suggest books and articles for exploring a particular topic in greater detail. Also included are sources of brochures or other materials to share with students. A Suggested Student Reading section lists references for students.

EVALUATION DESIGN AND PROCEDURES

A. Evaluation Questions/Study Variables

The impact evaluation study focused on two major areas of effect: science career awareness and student attitudes. Evaluation questions were stipulated in each area.

One question addressed the area of science career awareness. Science career awareness was conceptualized as students' knowledge of science, scientists, science careers, and the scientific enterprise.

Four questions addressed the area of student attitudes. Various related dimensions of affect were selected for study. These included attitudes toward science, toward science careers, and toward the potential of deaf persons in science careers. The latter area was seen as a

primary focus of the impact evaluation study since it reflected the highest priority objective of the program development effort. In addition, self-concept was selected as a fourth area of attitudinal effect. The relationship between career development and self-concept has been clearly established in other studies (e.g., Bailey, 1976; Bisconti, 1975; Tillery, 1968; and Biester, Kershner, and Blair, 1978). Also, deficiencies in the self-concept area have generally been noted in studies of deaf students. These evaluation questions define the scope of the impact evaluation effort.

B. Site and Sample Selection

Nine schools along the East coast participated in the field test of Is Science a Possible Career for You?. The sites which were selected represented each of the predominant communication techniques used with deaf students: 1.) oral; 2.) finger spelling and speech; and 3.) total communication. In addition, three types of school setting were considered: 1.) residential; 2.) day; and 3.) mainstream. One site was selected for each cell in the 3x3 matrix of variables covering the above two dimensions (nine sites).

Sites which were chosen are located in various geographic points along the East coast, including Rhode Island, Florida, Pennsylvania, New York (two sites), Maryland, Delaware, Massachusetts, and the District of Columbia.

The selection of students to participate in the field test of the science career development program was left up to each individual site following a description of the program and the intended user group.

Approximately 130 students, ages 13 to 19, participated in the field test across all sites*. The number of participants at each site ranged from 4 to 43. Most sites had a small number of participants. Detailed information on background characteristics of the participating samples was not available. All students at each site who were judged by school staff to be able to benefit from the career development experience participated in program activities. Thus, the use of comparison groups was not feasible in the impact evaluation study.

C. Instrumentation

Existing instrumentation which addressed the evaluation questions was not available. It was necessary for Research for Better Schools to develop two new forms for the impact evaluation study. These were the Awareness of Science Form (ASF) and the Student Attitude Inventory (SAI). Various subscales of the SAI are described below.

- Attitude Toward Science, in General
- Attitude Toward Science Careers
- Attitude Toward the Potential of Deaf Persons in Science Careers
- Self-Concept

Several existing measures and reviews of instrumentation were analyzed in the instrument development effort (Stice, 1958; Doran, Guerin, Cavelieri, 1974; Kimball, 1968; Schwirian, 1968; Stolte & Unks, 1971; Korth, 1976; Klopfer, 1976; Cooley & Klopfer, 1961; Kozlow & Nay, 1976; and Patrick, 1977). None were viewed to be completely adequate in addressing the special objectives and population of the present study.

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* Complete pre-post evaluation data are available for 93 participating students.

However, many items from the above scales were adapted for the two measurement forms.

Items on the ASF are based upon the cognitive objectives listed for the program activities. At least two items were developed for each cognitive objective. Items were designed in a "True/False" response format.

The SAI used a four-point Likert-type response scale with "Strongly Agree" and "Strongly Disagree" as scale polarities. Several teachers noted that students had some difficulty in the interpretation of this response scale.

D. Data Collection Procedures

All data collection was conducted by site staff. Forms were administered on a pre-post basis and mailed back to RBS. Test administrators were encouraged to standardize all procedures but were permitted to explain directions when students did not understand them.

Site staff were asked to send a short description of administration conditions which included the notation of testing environment, schedule of administration, special instructions, and administrations problems. It appears that no major administration problems occurred in test administration and that pretest and posttest conditions were essentially similar at all sites.

E. Analysis Plan

The data analysis plan for the impact evaluation centered around the comparison of pretest and posttest results within each site. Analyses were designed to answer all evaluation questions and to test each of the

stated hypotheses. For all hypothesized effects the scheduled analyses were one-tailed t-tests for paired data using matched pretest and posttest scores. These analyses tested for the statistical significance of growth within the program groups. It should be noted that t-test procedures are very weak when sample sizes are small. However, it was judged that alternative analyses, such as non-parametric techniques, also have problems of power. The .05 level of significance was chosen for all analyses.

RESULTS AND CONCLUSIONS

Results of the impact study in each of the five areas of hypothesized effect are briefly summarized below. (Actual results are available in the Appendices.)

Students at each of the nine field test sites demonstrated growth in awareness of science. Growth at three of the nine sites was of sufficient magnitude to produce statistically significant effects. Thus, there is some evidence to indicate that students become more aware of the nature of science, scientists, and the scientific enterprise after participating in the program.

There is only very slight evidence to indicate that students develop increased positive attitudes toward science and science careers and increased positive self-concept. Statistically significant gains were demonstrated at only a few of the participating sites in each of the respective areas listed above. No statement of program impact can be made in any of these areas.

Extremely positive results were exhibited in students' attitudes toward the potential of deaf persons in science careers. Significant gains were demonstrated at five sites; ceiling effects were found on pretest results at two sites. Thus, seven of the nine sites demonstrated very positive attitudes in this area at the time of program completion. Since this area addresses a primary objective of the science career development program, results are considered to be very favorable.

It should be noted, however, that several problems in the evaluation design limit the extent to which definitive conclusions about program impact can be made. Although many of these problems were anticipated prior to undertaking the impact evaluation study, most could not be resolved due to practical or budgetary constraints. These problems include the short duration of program operation (which is a particular problem given the program's attitudinal objectives), the lack of psychometric back-up data on evaluation instrumentation, the impossibility of control groups, the small sample sizes and concommitant data analysis problems, the lack of information on student background characteristics, and the lack of process data on patterns of program use. These problems should be considered in the interpretation of program effects, and conclusions should be regarded as somewhat tentative.

In conclusion, participation in the Is Science a Possible Career for You? program appears to be a valuable experience for students. Impact upon students' attitudes toward the potential of deaf persons in science careers was clearly established. Students were much more favorably disposed to see the possibility of deaf persons entering

science careers after participating in the program. Thus, a primary objective of the program is being achieved. In addition, there is some evidence to suggest that students' awareness of the nature of science and scientists increases after participation in the program.

These findings and this product are important in light of the small number of deaf individuals presently in science careers and the dearth of science career development resources now available for deaf students.

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Table 1

Results of Awareness of Science Form (ASF)

School	N	$\bar{X}$	s_x	$\bar{Y}$	s_y	t
A	7	15.29	1.28	19.29	2.43	6.16 **
B	7	19.29	2.25	20.43	1.96	1.24
C	4	12.00	0.00	13.75	0.83	2.11
D	6	13.83	2.11	15.83	0.90	2.07 *
E	4	14.25	1.48	15.00	1.58	0.73
F	8	12.63	2.06	13.23	1.45	0.68
G[1]	18	15.16	2.50	15.53	2.89	0.81
H	35	15.20	2.30	19.14	2.11	3.09 **
I	4	17.50	3.35	18.50	3.35	1.15

* $p < .05$, one-tailed test, df = n-1

** $p < .01$, one-tailed test, df = n-1

[1] Site G used pilot test versions of materials and evaluation instruments.

KEY: X = pretest
Y = posttest

Table 2

Results of Student Attitude Inventory (SAI)

School	N	Attitude Toward Science					Attitude Toward Science Careers					Attitude Toward Deaf in Science Careers					Self-Concept				
		$\bar{X}$	s_x	$\bar{Y}$	s_y	t	$\bar{X}$	s_x	$\bar{Y}$	s_y	t	$\bar{X}$	s_x	$\bar{Y}$	s_y	t	$\bar{X}$	s_x	$\bar{Y}$	s_y	t
A	7	3.13	.26	3.05	.31	-1.28	2.78	.37	3.03	.37	2.06*	3.73	.26	3.65	.42	0.74	3.69	.13	3.43	.40	1.54
B	7	3.02	.34	3.33	.48	2.06*	2.88	.20	3.07	.33	0.93	3.71	.25	3.91	.22	2.36*	3.17	.30	3.50	.28	1.23
C	4	2.14	.46	2.43	.41	1.20	2.25	.44	2.50	.39	1.14	2.54	.39	2.64	.37	0.74	2.17	.42	2.17	.43	0.00
D	6	3.21	.31	3.18	.31	0.35	3.14	.31	3.28	.30	0.63	2.95	.33	3.36	.29	2.06*	3.42	.28	3.19	.32	1.01
E	4	2.30	.43	2.32	.44	0.20	1.83	.52	1.75	.52	-0.57	2.93	.32	3.25	.30	2.62*	2.67	.36	2.62	.35	-0.24
F	8	3.01	.33	3.34	.38	2.30*	3.17	.31	3.28	.30	0.86	2.34	.42	2.70	.36	2.73*	2.88	.35	3.11	.32	3.73**
G[1]	18	3.17	.31	2.99	.33	-2.00	2.65	.36	2.75	.36	1.72	2.98	.33	2.88	.36	-1.16	2.74	.36	2.69	.36	-0.74
H	35	3.26	.30	3.23	.31	-0.64	3.32	.30	3.40	.29	0.98	3.23	.30	3.52	.28	2.61**	3.15	.31	2.81	.35	-3.88
I	4	3.39	.29	3.43	.29	0.44	3.33	.30	3.29	.30	-0.22	3.61	.28	3.64	.27	0.22	2.84	.35	3.13	.32	1.21

* $p < .05$, one-tailed test, df = n-1

** $p < .01$, one-tailed test, df = n-1

[1] Site G used pilot test versions of materials and evaluation instruments.

Key: $\bar{X}$ = pretest
$\bar{Y}$ = posttest